Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

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Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

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SOME OBSERVATIONS ON THE EDIBILITY OF FUNGI FOR RODENTS.

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IN the following pages an attempt will be made to show that fungi are eaten by squirrels and rabbits to a larger extent than is generally supposed.

In September, 1913, one of us was walking in some woods a few miles from Vienna, when a toadstool, a species of *Flammula*, which grows on the ground, suddenly fell at his feet. The cap of the toadstool was broken, perhaps, by its fall, but the stalk was still attached to it. On looking round to see whence the toadstool had come, a little brown squirrel was seen sitting on the branch of a tree immediately overhead. Although no tooth-marks were seen in the toadstool, there appeared to be no doubt that it had been dropped by the squirrel. The same thing has been noticed by other observers. A correspondent of *Country Life* for September, 1913, writes: "I might say that in the summer of 1910 I observed a squirrel eating a dark species of toadstool. The little animal was sitting on an oak tree, nibbling at something. A moment later it let fall the remains, which proved to be the stalk of a toadstool. It then descended the tree, ran to a spot where a number of toadstools grew, picked one up, and returned to the oak. The stalk was again dropped."

In his book, "British Fungi"[1] Massee figures a specimen of *Boletus scaber* "showing tooth-marks of a squirrel." In Epping Forest, Byfleet, and Oxshott Woods we have found specimens of *Boletus edulis*, *Boletus badius* (see Figures 89 and 90), and *Boletus chrysenteron* (see Figure 88), all showing undoubted tooth-marks of a small rodent. All these were found in the early autumn, and in some cases the greater part of a large fungus, weighing two or three ounces, had been eaten. In at least three cases, in which a fairly large fungus had been attacked, two little holes, one on each side of the area that had been most eaten, were seen. These were clearly produced by the pressure of the front paws of a small animal: they can be made out rather indistinctly in Figure 88. We have also found, in July, a specimen of *Paxillus atrotomentosus*, showing undoubted tooth-marks. All the fungi so far mentioned are relatively large and succulent, and tooth-marks are easily seen in them. Although there is evidence that many of the smaller and more fibrous toadstools are also eaten by rodents, tooth-marks are much more rarely found. From these last small pieces seem to be seized and torn off, whereas the larger and more succulent are eaten very much as a boy eats an apple.

The fungi so far described were all eaten in the late summer and early autumn. As the year advances, other specimens become attacked. *Hygrophorus hypothejus* (see Figure 92) is a very common fungus in Oxshott Woods. It grows in groups, and from the middle of November to the end of December is very much eaten. In some specimens definite tooth-marks are to be seen, but most appear to have been bitten through at the highest part of the stalk, the caps turned over, and the gills nibbled as they lay on the ground. *Paxillus*

involutus (see Figure 91) was also eaten pretty extensively at Oxshott about the middle of November, and one large specimen of *Boletus variegatus* was found much eaten, and showing definite tooth-marks about this time.

But except for *Hygrophorus hypothejus* and *Paxillus involutus*, it is not until the frosts begin, and the ground becomes hard and food scarce, that many different fungi are eaten. During November and December it would seem that fungi must form a very important article of diet for rodents. On November 28th, 1915, every species of toadstool found growing in Oxshott Woods, except *Flammula sapinia* and *Fomes annosus*, showed tooth-marks of small rodents. The species eaten were as follows :—

Hygrophorus hypothejus (see Figure 92). — More than half the specimens nibbled, and many almost completely eaten.

Paxillus involutus (see Figure 91).—Over half the specimens nibbled, but very few much eaten.

Cantharellus aurantiacus.—About a quarter of the specimens eaten, and several almost completely.

Lactarius rufus (see Figure 93). — Perhaps a quarter nibbled, but very few much eaten.

Russula emetica (see Figure 96). — About one-sixth of the specimens seen was eaten, but none very much.

Boletus variegatus.—A few eaten.

Boletus badius.—A few eaten.

Tricholoma terreum.—A few eaten.

Elaphomyces granulatus.—A few eaten.

Boletus bovinus.—A very few eaten.

Clitocybe brumalis.—A very few eaten.

Collybia maculata.—A very few eaten.

In some specimens of each of the above species definite tooth-marks were seen, such as could not possibly have been made by slugs, which are well known to eat fungi extensively. In some species, such as *Boleti*, every specimen eaten showed tooth-marks ; in others of a more fibrous nature, such as *Paxillus involutus* (see Figure 91), tooth-marks were only seen in a very few. One specimen of the poisonous Fly Agaric (*Amanita muscaria*) showed a tooth-mark. It had evidently been tried, but not approved of.

From the size of the tooth-marks it would seem probable that most of the fungi had been eaten by squirrels rather than by rabbits. Only one fungus which grows on trees, *Polyporus betulinus* (see Figure 95) has been found with tooth-marks on it. This specimen was, however, growing on a fallen tree, and the tooth-marks, from their size, appear to be those of a rabbit.

In order to substantiate the field observations, a few simple feeding experiments were carried out to see whether squirrels will eat fungi. The grey American squirrel (*Sciurus cinereus*) was used. The animals were quite tame, fed from the hand, and were at large during the day. Food was given to them regularly, and consisted chiefly of nuts. Any excess of food is buried by them in the ground for future use ; but it cannot be recovered when the ground is frost-bound. This has a bearing on the feeding experiments, for it was found that on a frosty morning, when this supply was cut off, the animals had a hearty appetite, and accepted fungi which at other times were refused. Only small pieces of fungus were given, and these were treated by the animals in one of three ways : (1) They were taken in the fore-paws, quickly brought in front of the nose, then dropped. This is called refusal (R). (2) They were taken in the fore-paws, brought to the nose, put into the mouth, and then broken into pieces by the incisor teeth. In doing this the tip of the tongue comes into contact with the pieces, and there is no doubt that the animals are tasting the food. In the experiments this is called nibbled (N). (3) They were broken into pieces by the front teeth, passed back to the molars, crushed, and finally swallowed. This is called eaten (E).

TABLE 17.

Fungus.	Animals.					
	A	B	C	D	E	F
Amanita muscaria ...	E_1	E_5	R_4	R_3	E_1	N_1
Russula emetica	R_2	R_1	N_5	N_4	E_2	
Hygrophorus hypothejus ...	N_3	N_2	E_1			
Collybia maculata ...	N_4	N_3	N_2	R_1	R_3	
Flammula sapinia ...	N_5	N_4	R_3	R_2		

The ground was soft.

TABLE 18.

Fungus.	Animals.			
	A	B	C	D
Paxillus involutus	N_1	R_2	R_3	R_2
Cantharellus aurantiacus	R_2	N_1	R_2	N_1
Clitocybe brumalis	R_3	R_3	N_1	R_3

The ground was soft.

TABLE 19.

Fungus.	Animals.					
	A	B	C	D	E	F
Collybia maculata ...	R_1	R_1	E	N_2	E_3	N_3
Cantharellus aurantiacus ...	R_2	N_3		N_1	R_2	R_2
Paxillus involutus... ...	R_3	R_2		R_3	R_1	R_1

The ground was soft.

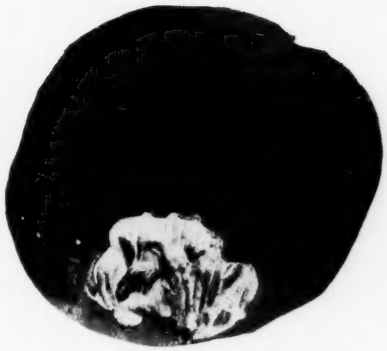

FIGURE 88.
Boletus badius, showing tooth-marks of squirrel.

FIGURE 89.
Boletus chrysenteron, showing tooth-marks of squirrel.

FIGURE 90.
Boletus badius. Sampled but not approved by a squirrel.

FIGURE 91.
Paxillus involutus. Several caps are partly eaten by squirrels.

FIGURE 92.
Hygrophorus hypothejus, with caps removed, partly eaten by squirrels.

FIGURE 93.
Lactarius rufus nibbled by squirrels.

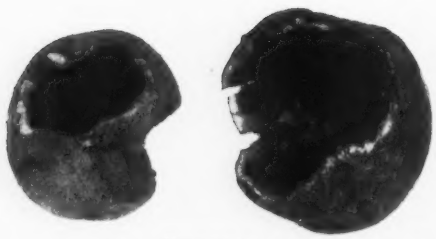

FIGURE 94.

Two specimens of *Elaphomyces granulatus* found partially eaten in burrows.

FIGURE 95.

Polyporus betulinus, showing tooth-marks probably of a rabbit.

FIGURE 96.

Russula emetica partly eaten by squirrels.

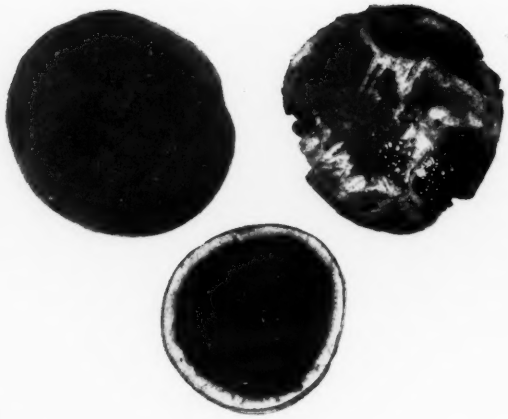

FIGURE 97.

Elaphomyces granulatus. One specimen photographed from above, another in section, and a third nibbled and showing tooth-marks. ×3/2.

FIGURE 98.

Elaphomyces granulatus, showing tooth-marks in burrows made by some small animal.

TABLE 20.

Fungus.	Animals.				
	A	B	C	D	E
Amanita muscaria	R_1	E_1	R_2	E_1	E_2
Hygrophorus hypothejus... ...	R_2	N_2	N_1	N_2	E_1
Lactarus rufus	R_3	N_3	R_3		

The ground was soft.

TABLE 21.

Fungus.	Animals.							
	A	B	C	D	E	F	G	H
Hygrophorus hypothejus	N_1	E_1	E_5	E_4	N_3	E_5	R_4	R_1
Paxillus involutus ...	E_2	N_2	N_1	N_5	N_4	E_4	E_5	
Elaphomyces granulatus	N_3	N_3	N_2	N_1	R_5	N_3	R_1	
Boletus variegatus ...	N_4	N_4	E_3	E_2	N_1	E_2	E_2	
Boletus bovinus ...	R_5	R_5	R_4	N_3	N_2	E_1	E_3	

The ground was frozen.

TABLE 22.

Fungus.	Animals.				
	A	B	C	D	E
Collybia maculata	E_1	E_3	N_2	E_1	N_3
Paxillus involutus	E_2	N_2	N_3	N_2	E_1
Hygrophorus hypothejus... ...	E_3	E_1	E_1	E_3	E_2

The ground was frozen.

The preceding six tables give the experimental data. The first column gives the fungi: ten species were used. Of the other columns, each deals with a single animal, marked at the column heads, A, B, C, D, and so on. The letters in these columns indicate whether the fungus was refused, nibbled, or eaten. The subscript figures represent the order in which the fungi were given. Beneath each table a note is made as to whether the ground was frost-bound or not. The tables show that several fungi, which had been repeatedly refused on warm mornings when the animals were not very hungry, were eaten on frosty mornings when their appetites were keen. Field observations are in keeping with this finding, for in the early frosts of winter many fungi were found eaten which before had not been touched. Eight species of fungi were tested on frosty mornings; only one, *Elaphomyces granulatus*, was not eaten. It was nibbled on two occasions; but directly the black dry spores within were exposed, the fungus was dropped. The specimens of *Elaphomyces* used in the experiments were rather dry, and the outer covering was hard; this might account for it being refused. It is noteworthy that in five out of seven cases it was nibbled. The experiments also show that fungi poisonous to man are not unpalatable to squirrels. It can be seen that *Amanita muscaria* was eaten on six occasions, *Russula emetica* once. It is noteworthy, however, that the American squirrel was used, and that therefore neither the animals nor their ancestors can have had much experience of English fungi. The experiments show that squirrels will eat fungi of their own free choice, even when other food is available.

The false truffle (*Elaphomyces granulatus* (Figure 97), which is fairly common in Oxshott Woods, is found at one to three inches below the surface of the ground, generally at the level of junction of the layer of leaf mould with the sandy soil of the Bagshott Sands, on which formation Oxshott Woods are situated. This false truffle is about the size and shape of a small walnut, but is somewhat flattened from above downwards. When ripe it consists of a hard, leathery covering, about an eighth of an inch thick, enclosing a powdery mass of black spores. It has a faint earthy smell. In situations where the false truffle is likely to be found, numerous shallow burrows, one to four inches deep, were noticed from November to February. We have seen no fewer than six or eight of these in as many square feet, and close by them are frequently to be seen the droppings of small animals, which correspond with those of squirrels and rabbits. On digging around the burrows, specimens of *Elaphomyces* were not infrequently found, and in the burrows round depressions were several times seen where, in all probability, these fungi once rested. Some burrows (see Figure 98) contained false truffles which had been nibbled, and many contained specimens which were half eaten (see Figure 94). Beside another burrow was a specimen that had been fairly extensively eaten, and showed definite tooth-marks; another (see Figure 97), which was found some distance away from any burrow, showed these even better. Russ and Fisch[2] have observed that specimens of *Elaphomyces* are dug up and eaten by wild animals at all times of the year, and Du Reau[3] states that *Balzamia vulgaris*, an allied species, is excavated and eaten by squirrels. He thinks that it is the nut-like smell which the fungus acquires with age that is attractive to these animals. Du Reau further tells us that the scratchings made by squirrels are round, with the earth thrown out on all sides, while those made by rabbits are oval, and have the soil thrown out on one side only. At Oxshott both types of burrow are to be seen; and from the size of the tooth-marks it would appear that those specimens found eaten while still in the burrows have been attacked by rabbits (see Figure 94), while those which have been removed from the ground (see Figure 97) have been sought for by squirrels. We have found that tame rabbits will readily eat *Elaphomyces*, and it

has already been shown that squirrels also will take this fungus. In those fungi found extensively nibbled, hardly any of the powdery spores were removed. It is therefore probable that the outer covering only is palatable.

Lastly, it may be useful to inquire what advantage, if any, it is to a fungus to be eaten by animals. The spores of many fungi have been shown to pass unharmed through the alimentary canal of mammals. From the contents of the intestines of newly killed rabbits, extracted under conditions which make it impossible that any spores should have reached them from the air, many fungi have been grown. There is, indeed, a whole class of toadstools which grow exclusively on the dung of various herbivora. From the toadstools which are produced spores are shed, and are carried by the wind to fall on the grass or other vegetation which forms the natural food of these animals. After passing through the alimentary canal the spores are deposited under ideal conditions for their germination and growth. Many species of toadstool, and particularly the gills of Agarics, are frequently eaten by slugs, and the germinating spores of *Russula* and *Lactarius* were found by Voglino in the digestive tracts of slugs that were fed on these toadstools. Further, this observer showed that the spores of other species that would not germinate on ordinary culture media did so readily in the fluid from the digestive tract of a slug. The regular, and, so far as is known, sole, method of spore dispersal in the stinkhorns (*Phallus* and *Mutinus*) is by means of flies, and here, again, it has been shown that the spores germinate well after passing through the alimentary canals of these insects. It is well known also that the edible truffles are eagerly sought for by pigs, and greedily devoured by them; and the fact that these fungi are only strong smelling when quite mature, and filled with ripe spores, suggests that this must be something of a coöperative arrangement, and that it is really to the interest of the fungus to be thus eaten. But most of the fungi that are eaten by small rodents are of the umbrella type, with gills or pores, a type which is so well adapted for the distribution of its spores by means of air-currents that it has become predominant in the fungus kingdom. Moreover, we have found that the toadstools are most eaten at the beginning of winter, when the bulk of the spores is shed, and, except in the case of *Hygrophorus hypothejus*, the gills or pores on which the spores are produced are generally less eaten than the rest of the pileus. It is probable, therefore, that any assistance that most fungi derive from animals in the distribution of the spores is of quite secondary importance.

With the false truffle (*Elaphomyces granulatus*) the case is, however, quite different. This fungus lies buried in the ground, and its spores are enclosed by a thick leathery cuticle which does not spontaneously rupture. The Devil's Snuff-box (*Sclerodoma*) resembles it closely, except that it grows on the surface of the soil, and has its spores distributed by beetles, which eat their way into and through the fungus, and leave behind them, as indications of their work, a number of small holes in the lower part of the leathery coat. In *Elaphomyces* we have never seen such holes, and it is probable that the fungus is almost entirely dependent on small animals for the distribution of its spores. Russ and Fisch[2] have found the spores of *Elaphomyces* unchanged in the excreta of wild animals, as well as those of animals fed experimentally on the fungus. They were unable, however, to induce the spores to germinate. When buried in the soil, and when left exposed to the air for as long as five years, they remained unchanged; nor did the employment of culture media of various decoctions and ferments give any better result.

CONCLUSIONS.—The above observations indicate that—

1. In early autumn, when food is plentiful, only a few specimens of fungi are eaten by rodents.

2. But in frosty weather, when food is more scarce, very many species are extensively eaten.

3. Squirrels and rabbits appear to be the rodents which most commonly feed on fungi.

4. Only in the case of the buried fruits of the false truffle (*Elaphomyces granulatus*) do rodents appear to assert materially the fungus in the distribution of the spores.

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NOTES.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

DARK MARKINGS IN THE SKY.—Professor E. E. Barnard contributes an article on this subject to the January number of *The Astrophysical Journal*. The suggestion that they are due to dark nebulous matter is not new, but he elaborates it. Where the background is luminous, as in the Milky Way, we can trace the boundaries of the dark nebula as easily as we can in a bright nebula. He reproduces a dark marking in Cepheus, which shows a close resemblance to the bright nebula N.G.C. 6995. As the outlines of some of these dark nebulae can be traced, even in non-galactic regions, Professor Barnard concludes that there must be a feebly luminous background in most regions of distant space, capable of impressing itself on the

photographic plate with prolonged exposure. He conjectures that some nebulous matter may never become luminous at any stage in its career, though, of course, it is possible that some nebulae that were once luminous may become dark without condensing into stars. Professor Barnard thinks the mass of these dark nebulae must be considerable, from the amount of light they stop; hence allowance should be made for them in studying the gravitation of the stellar system.

MUTUAL OCCULTATIONS OF JUPITER'S SATELLITES.—It is curious how few of these phenomena have been recorded. Several of them must occur when we see the orbits edgewise, as we do every six years. Probably the reason is that they are not predicted in the almanacs, so observers are not on the alert. Mr. A. T. G. Apple records three such phenomena observed by him in 1914 with an eleven-inch refractor (*Popular Astronomy*, March, 1916).

G.M.T.			Phenomenon.	——
1914. d.	h.	m.		
July 22	20	43·3	I occults II	First contact.
		46·1	,,	Middle (perhaps late).
		49·0	,,	Second contact.
Aug. 3	17	14·6	III occults IV	First contact.
		18·1	,,	Middle.
		21·8	,,	Second contact.
Oct. 21	13	14·2	III occults II	Middle.
		16·7	,,	Second contact.

Diagrams of the August and October phenomena are given. According to these, III covered about one-third of the diameter of the other satellite on each occasion.

MARS.—Professor W. H. Pickering has been making regular observations of Mars during the present apparition, at his observatory at Mandeville, Jamaica, and has printed an account of them, month by month, in *Popular Astronomy*. One point that he makes is that several markings are liable to considerable shift on the surface of the planet. He notes as examples Oxia Palus, the junction of Nectar and Aurorae, the Syrtis Minor, Siloe, Juventae Fons, Propontis, Trivium Charontis, Ismenius. The shift of some amounts to two hundred miles. The explanation suggested is that they are swamps with low ground round them, so that a small alteration in the water-level means a considerable change in the area covered. Incidentally he remarks that, while some people commiserate with the Martians for having so little water, he would rather congratulate them on not having more, or they might all be drowned. He gives the following as not liable to shift: Hamonis, Edom, junction of Euphrates and Sabaeus, Phoenicis, Titanum, and the centre of Lacus Solis. Such points should be selected when making observations for determining the rotation period.

Another interesting research is the comparison of Martian meteorology in different revolutions. There would appear to be warm and cold years on Mars, as on Earth. A simple observation is to tabulate the size and position of the polar snow-cap on various dates. The date of maximum extent of the northern cap fluctuates from December 16th to March 29th (Martian calendar), and the limiting latitude fluctuates from 45° to 67½°. It is suggested that the cap which attained a maximum in December was not snow, but cloud or mist. These clouds disperse about the time the snow attains its maximum extent. It then appears very brilliant, but soon diminishes in size. There is a prevalence of white mist on the morning limb, as Lowell has also noted, and this sometimes makes the polar cap appear larger than it is. Its limiting parallel of latitude should be measured on the central meridian. He notes that the Maria were very faint in the early spring of the northern hemisphere, suggesting that the vegetation had not come into leaf. Acidalium Marsh was dark, and showed polarisation, so it is concluded to be water. The observations suggest that in Martian years, when the snow is late in melting, the Maria are also late in exhibiting their vegetational (?) darkening, which would be agreeable to terrestrial analogy.

He gives two interesting instances of permanent change on the planet. The first is a large gulf, tapering to the right, in the position now occupied by Juventae Fons. It can be seen on drawings of Lockyer, Kaiser, Dawes, Green fifty to forty years ago. The other is a sort of twin gulf to Margaritifer, to the left of it. This is also shown on the drawings of fifty years ago, but cannot now be seen. The fact that Mars is a living and changing world adds greatly to its interest, and shows that observers need never fear that it will be "played out."

I note that M. Antoniadi, in his report on the 1911 apparition, expresses the opinion that Mars is a habitable world. He is thus in agreement on this point with Professor Lowell, though they differ utterly on the subject of the canals. The latter looks on them as due to artificial irrigation; the former considers that their geometrical regularity is a pure illusion, and that they are merely the small, imperfectly seen detail of the land surface.

COMETS. — I have lately had an interesting Fijian tradition of a bright comet, seen in Fiji at the end of the eighteenth century, brought to my notice by Mr. E. im Thurn. "When dawn was near they saw a three-tailed star rise above the horizon. The appearance was presaged by a brightness in the sky, the comet itself soon appearing. The middle tail was the largest, and in brightness resembled the hues of a rainbow. The other tails, one on each side, were equal to each other and white. The comet was seen for thirty-seven nights, after which our forefathers saw it no more. They took it as an omen of the death of their chief" (which, in fact, followed soon). Another account adds that a wasting sickness decimated the people at the same time. From the approximate date given by Mr. im Thurn I conclude that the comet was probably 1799 II, in perihelion on Christmas Day, 1799, which was seen for ten days in Europe with a tail 1° to 3° long. I have calculated an ephemeris, and find that it approached the Earth during January, 1800, but went into high south declination, so as to be invisible in Europe, but conspicuous to the Fijians. If my identification is right—and I have since found that the same problem was put to Mr. H. P. Hollis in 1894, and that he adopted the same comet—we are indebted to the Fijians for the knowledge that this was really a much grander comet than we should have suspected from the European accounts. We may compare the mediocre aspect of Halley's Comet in the British Isles with the grand spectacle that southern observers witnessed. The identification helps to fix the date of early European intercourse with Fiji and the beginning of the sandalwood trade. Mr. im Thurn tells me that the ship "Argo" was wrecked in Fiji about the time of the comet.

Neujmin's Comet (*a* 1916) is another member of Jupiter's family, with a period of about 6·3 years. It was nearest to the Sun on March 10th. The plane of its orbit and direction of perihelion are nearly the same as those of Encke's Comet; but this is a mere coincidence, as the perihelion distance of Encke is inside Mercury's orbit, that of Neujmin outside the Earth's orbit; also its period is double that of Encke. It will be too faint for easy observation by the time this appears.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (OXON), F.I.C.

COMPOSITION AND USES OF SEAWEEDS.—A recent issue of *The Journal of the Board of Agriculture* (1916, XXII, 1095) has a suggestive paper, by Mr. J. Hendrick, upon the value of seaweeds for fertilising and other purposes at the present time. Of those growing between high- and low-water marks the most important are *Fucus vesiculosus*, *F. nodosus*, and *F. serratus*; while *Laminaria digitata* and *L. stenophylla*, which are known as "drift weed," and grow in shallow water below

low-water mark, are still more valuable as manures. The proportion of water in both kinds of seaweed ranges from seventy to eighty-five per cent., and samples of the dry material gave the following percentage results :—

TABLE 23.

Seaweed.	Organic matter.	Soluble ash.	Insoluble ash.	Silica.	Nitrogen.	In soluble ash.				Iodine.
						Potash.	Soda.	Sulphuric acid $(SO)_3$.	Halogens as chlorine.	
L. digitata, stems	64·03	27·98	7·37	0·66	1·31	10·49	5·35	2·94	9·92	0·54
L. digitata, fronds	77·28	17·30	4·59	0·82	1·30	5·25	4·24	2·97	6·11	0·38
L. stenophylla, stems	64·73	29·00	5·73	0·53	1·02	12·35	4·91	1·77	11·28	0·32
L. stenophylla, fronds... ...	77.76	18·84	4·13	0·26	1·08	4·49	4·91	2·42	6·56	0·29
F. vesiculosus	79·71	16·08	3·30	0·92	1·18	3·07	4·51	5·71	3·44	0·04
F. nodusus	78·39	16·90	4·14	0·57	1·13	2·52	5·78	5·46	3·50	0·09
F. serratus	77·56	17·30	4·53	0·62	1·50	4·18	4·85	3·95	4·70	0·05

Referring to these analyses, Mr. Hendrick points out that at the present price of potash dried *Laminaria* would be a valuable manure. It is also rich in iodine, the ash yielding from thirty-three pounds to forty pounds per ton. The *Fuci*, when dried, are less valuable than *Laminaria* as fertilisers; but, as they are plentiful on many parts of the coast, it would pay to burn them and use the ash as a potash manure.

Cattle and sheep will eat the seaweed *Alaria esculenta* and the fronds of *Laminaria stenophylla*, but it is doubtful whether they would eat *L. digitata*.

EXPLOSIBILITY OF URANYL NITRATE.—It was found by Andrews that certain preparations of uranyl nitrate separating from a solution of the salt in ether decrepitated sharply when rubbed, and the conclusion was drawn that this was a definite property of the compound. According to recent experiments of Dr. A. Müller, however (*Chem. Zeit.*, 1916, XL, 38), the phenomenon must be attributed to the formation of an unstable compound of a lower oxide of nitrogen with an addition compound of uranium and ether. Such decrepitations were only observed in the case of preparations from aqueous solutions containing some free nitric acid, and never with products crystallised from water.

LEAD FROM RADIO-ACTIVE MINERALS. — A further proof of the difference between ordinary lead and that obtained from radio-active minerals is afforded by the determinations of the respective densities made by Messrs. T. W. Richards and C. Wadsworth (*Journ Amer. Chem. Soc.*, 1916, XXXVIII, 221). The density of ordinary lead, with atomic weight 207·2, was found to be 11·337; while that of radio-active lead (atomic weight 206·3) was 11·28. The radio-active lead was converted into nitrate and chloride, and these salts were fractionally crystallised many times, but in no case did the lead recovered from the several fractions show any variations in their density.

YEAST AS FODDER IN GERMANY.—The *Zeitschrift für angew. Chem.* (1915, XXVIII, 697) gives an account of the new process recently instituted in Germany for the production of a special yeast which is used as a feeding-stuff for cattle. This yeast produces no alcohol, but multiplies much more rapidly than distiller's yeast. It is grown in solutions sweetened with waste molasses, and containing ammonium and other salts, the vats used being of the size of public swimming baths, with tubes at the bottom for aërating the liquid. Not only is there an increasing demand for dried yeast for fodder, but large quantities are also being prepared for the army and public services under the name of "nutrient yeast," and the German Government is now organising the installation of plant capable of producing up to fifteen thousand tons of the product per year. The new process has been devised by the Institut für Gärungsgewerbe, and the eventual aim is to make Germany independent of imported albuminous fodder. It is estimated that for this purpose an output of three hundred thousand tons of dried yeast per annum would be required. The waste products from starch, sugar, and cellulose factories could take the place of molasses in the liquids for the cultivation of the yeast, no organic matter other than sugar being required.

GEOGRAPHY.

By ALEXANDER SCOTT, M.A., D.Sc.

THE SHACKLETON ANTARCTIC EXPEDITION.—The scanty news which has been received concerning this expedition indicates that the Ross Sea party have been very unfortunate. After the shore party had finally landed the ship broke away, and drifted in the ice in such a damaged condition that it was impossible for it to return to the Ross Sea. Hence its arrival in New Zealand gives little information regarding the expedition. The Ross Sea party will doubtless have undertaken the depot-laying and scientific work in the Beardmore glacier, as arranged; and, as there should be no shortage of food (much of the material left by Scott will be available, in addition to their own supplies). the party should be able to weather the winter until a relief ship arrives early next year.

At the time of writing there is unfortunately no news of the "Endurance," and unless it is spoken very shortly it must be assumed to have met with some mishap. Whalers' reports indicate that the ice conditions have been bad, and it is possible that the ship has been shut in and has drifted. Hence the sending of a relief ship to the Weddell Sea will also be necessary. There is, of course, no news of Sir Ernest Shackleton's trans-continental journey, but at present there is no need for anxiety, as, in the event of a failure to get across, the party should find no insuperable difficulty in returning to the coast. No detailed arrangements concerning these relief expeditions have yet been made; but, as they will have to be ready to start by late autumn, the initial arrangements will have to be made shortly.

SAND-RIPPLES AND DUNES.—In *The Geographical Journal* (February, 1915) W. J. H. King describes a number of experiments on the formation of sand-dunes, and criticises several of the theories advanced by Dr. Vaughan Cornish ("Waves of Sand and Snow"). He finds it impossible to accept the notion that dunes are waves, as the resemblances, both with regard to form and motion, are superficial. Types, such as the crescent, whale-backed, and star-shaped dunes, have no analogues among water-waves. Even transverse dunes, though morphologically similar to water-waves in their early stages, lose this identity later, owing to the development of a flat face on the lee-side. Again, the motion of a dune is due to erosion by wind, and "not to the interaction of its particles." Another difficulty arises with regard to the connection between dunes and ripples. If the former develop continuously from the latter, intermediate forms ought to be found, but these appear to

be absent. The movement of the individual sand grains is very irregular, and there is certainly no periodicity in their motion.

In the experiments a long wooden trough, with a layer of sand in the bottom, was placed parallel to the wind-direction and the formation of the ripples examined. The larger ripples which formed remain stationary, or only undergo slight oscillations; while the smaller ones tend to alter their positions more or less continuously. Several theories have been advanced to account for aeolian rippling. Baschin has ascribed it to "a tendency towards the formation of Helmholtz wave-surfaces"; while Cornish takes the view that eddies under the lee of large grains constitute the chief factor. King admits the operation of the latter in the case of already formed ripples, but holds that this theory fails where the surface is initially smooth, as it does not account for the fact that the direction of the ripple changes with that of the wind; while it also requires that the tendency to ripple should increase with the variation in grain-size, a phenomenon contrary to experience. The alternative theory advocated is that grains in unstable equilibrium are first moved: this removes the support of those to windward, and consequently exposes those to leeward. In the pits thus formed eddy-action would tend to set up. The paper concludes with an interesting note on the electrical conditions of sand.

A. S.

GEOLOGY.

FLUOR-SPAR.—Since the outbreak of war the Geological Survey has been investigating the production of some of the important minerals in the British Isles. The latest publication on this subject deals with the sources of supply of fluor-spar and the methods of working it. The commercial value of this mineral has only been realised within the last twenty years. Prior to the year 1898 it was regarded by miners as a valueless waste product, but since that time it has been in such great demand as a flux in the metallurgy of iron and other metals that it has been found profitable to work over old dump heaps, and even to reopen disused mines, to obtain supplies. The fluor-spar mined in this country is used by ironworkers both in Great Britain and the United States, whither a large proportion of it is sent. In addition to this, it is also used for the production of opalescent glass and glazed earthenware, the manufacture of hydrofluoric acid and other chemicals, as a binding material in carbon electrodes and emery wheels, as a decorative stone ("Blue John"), and for microscope lenses. For the last purpose only the very best spar can be used. A little has been found of sufficiently good quality in Weardale, but it has mostly been obtained in Switzerland.

The mineral is generally found as the "gangue," or "vein stuff," in lodes of lead, copper, or iron ores, the first being the most common.

The only areas in the British Isles in which it is found in any abundance are Weardale in Durham, the eastern portion of the Carboniferous Limestone district in Derbyshire, Cornwall and Flintshire. Of these the only two where it can be worked profitably are Durham and Derbyshire. In Durham it occurs in veins, which are generally fault fissures, associated with galena or chalybite, or some other iron ore. It seems to have been formed earlier than the galena and later than the iron ore, for in the lead veins it always forms the lining of the fissure, while in the iron veins it fills the centre. The mines in which the spar is now worked are all lead mines, some of which had been almost completely exhausted, so far as lead was concerned. In these mines the old miners had "slit" the veins, *i.e.*, they had cut the galena from the centre, leaving the fluor-spar behind. These old workings greatly facilitate the removal of the spar. The spar itself is generally purple in colour, though white is quite common. It is often quite fairly pure, the chief impurities being quartz, galena, and chalybite. These impurities are picked out by hand, and the spar is then graded according to size into "lump" and "gravel." The former, being composed of larger pieces, is preferred by the ironworkers; the latter is hardly marketable. In Durham nearly all the fluor-spar obtained is actually mined, but in Derbyshire, on the contrary, the chief source is the old "dump" heaps of the lead mines, which have been all worked over in the last few years till they are now nearly exhausted. In this county the spar does not occur so much along fault fissures as along joint planes and bedding planes of the limestone, large pockets being formed at certain places where the two planes cut one another. The colour is similar to that of the Durham spar, but the impurities are different, being chiefly barytes and calcite, instead of quartz. The process of preparing the material for the market is similar to that employed in Durham. In Derbyshire, near Castleton, the ornamental variety ("Blue John") is found lining fissures in some large caverns near the village. It has a banded and radial structure, the bands being alternately blue and white, and is prepared for the market by first hardening with resin, to prevent its breaking, and then polishing. The output is purposely restricted to two or three tons per annum. In Cornwall and Flintshire a little fluor-spar is found, but as it never amounts to more than ten or fifteen per cent. of the vein stuff it cannot be worked profitably.

W. H. W.

ANCIENT VOLCANOES IN SOUTH AFRICA.—It has long been known that there are in Cape Colony and the adjacent territories many interesting relics of volcanoes of ancient date. Some of these are so old that they have been reduced to the general level of the surrounding country, and may even form depressed areas; while in others the original form of the mountain is to a certain extent still preserved. In the former category come the well-known pipes of Kimberley and the Premier mine, which are filled with a peculiar rock known as "Blue Ground." In this are found diamonds. The special feature of this sort of breccia is that it is not composed of volcanic rocks in the ordinary sense of the word, but consists chiefly of fragments of the sediments through which the pipe has been drilled, with an admixture of blocks of igneous rock that appear to have been brought up from great depths by the explosion. Other necks, again, contain a plug of the rather rare rock type, melilite-basalt. It has been suggested that the blue-ground plugs are the result of a very watery kind of eruption, taking place at a comparatively low temperature, and perhaps partaking rather of the nature of a mud-volcano. Dr. A. W. Rogers has recently described, in *The Transactions of the Royal Society of South Africa*, another interesting volcanic mountain presenting some novel features. This mountain, called "Geitsi Gubib," is situated in what was formerly German South West Africa, near the Keetmanshoop Railway, rising to a height of about five thousand feet above the sea and one thousand eight hundred feet above the high plateau on which it stands. It is ring-shaped, and shows a very well-marked central depression, which, however, does not seem to be in reality the original crater, but merely a hollow produced by the more rapid weathering of the softer rock of the plug. The original outlines of the volcano were probably destroyed long ago by denudation. The central plug is very large, about two miles in diameter, and is filled by a peculiar breccia, consisting for the most part of sedimentary material, some of which may have come from the Karroo series. There are likewise abundant fragments of quartz-gabbro, and of felspar and augite, derived from the gabbro; but there are no specimens of those peculiar igneous rocks, such as eclogite, which are so characteristic of the Kimberley breccias. Around the neck the strata of the Fish River series show a very well-marked dip towards the centre, such as is seen in many other volcanoes, and they are likewise penetrated by two or three dykes filled with tuff. The breccias and tuffs resemble those filling pipes and fissures at other localities in South Africa, such as Saltpetre Kop, Kobe River, and Grenaat Kop, and also appear to have close affinities to some of the tuff-filled Carboniferous necks of Scotland. The most noticeable feature is undoubtedly the complete absence of fragments of lava of the ordinary types.

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The origin of tuff-filled necks of this kind presents a difficult problem, and several different explanations have been suggested. Some writers have even supposed that they may be due to the impact of gigantic meteorites, which burrowed down far within the crust of the earth, churning up the rocks and causing them to rise as a kind of pasty mass within the hollow thus produced. This explanation was suggested and discarded by G. K. Gilbert in the case of the Coon Butte crater in Arizona, since the difficulties involved were very great. It cannot, however, be rejected as wholly impossible in all instances. Nevertheless, it seems more probable that these breccia-pipes originated from a single great volcanic explosion at a considerable depth, which blew out the overlying rocks mingled with steam and gases, ceasing before lava had time to rise to any considerable height in the vent. At any rate, it is clear that the last word has not been written on this subject, and further investigation of the remains of old volcanoes in South Africa may be expected to yield results of great interest and importance.

R. H. R.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

RAINFALL OF NIGERIA AND THE GOLD COAST.—Mr. C. E. P. Brooks has collected all the rainfall data available for the northern and southern provinces of Nigeria and the Gold Coast, and has prepared from them monthly and annual means for the ten-year period 1904–13. He has communicated the results to the Royal Meteorological Society, together with a series of rainfall maps. The driest month is January, with scarcely any rain; the wettest is June; and the monthly maps show how the rainy belt travels inland as the wet season comes on. In August it reaches its northernmost position, and the coast is drier during that month than in July and September. The coast is very rainy, the annual fall averaging one hundred and sixty inches, and reaching two hundred inches in wet years at some stations in the Niger delta. The interior merges into the desert, with a rainfall of less than ten inches annually. The variation of the rainfall from year to year is governed by the development and movements of the equatorial belt of low pressure and the sub-tropical "highs," while it is the alternation of dry and wet seasons which governs the temperature and humidity, rather than the position of the sun, and the dominant factor in Nigerian climatology is not temperature, but rain.

DISTRIBUTION OF THUNDERSTORMS IN THE UNITED STATES.—The *Monthly Weather Review* for July, 1915, contains a paper, by Mr. W. H. Alexander, on the distribution of thunderstorms in the United States. He has tabulated the number of thunderstorms recorded at a large number of the Weather Bureau stations from the beginning of observations to 1913, and he gives tables of the totals for each month and year for the ten years 1904–13. The totals for this period are plotted on a series of maps, which show clearly the monthly and annual distribution of thunderstorms over the United States. No part of the country was entirely free from these phenomena. There are two centres of great activity, one over Florida and the other over northern New Mexico. The first gathers about Tampa, Fla., with its nine hundred and forty-four storms in ten years, and the second about Santa Fé, North Mexico, with seven hundred and ten to its credit. Tampa is a sea-level station, while Santa Fé is about seven thousand feet above the sea. The former is situated in what is perhaps the most humid portion of the United States, while the latter is in the arid regions. December has fewer thunderstorms than any other month, while July has the greatest number, taking the country as a whole. The area of maximum frequency in July is over the south-east, with a very marked secondary over the south-west, including the State of Colorado and portions of the adjoining States. Thunderstorms are also more frequent along the Mexican border. San Francisco and vicinity are apparently exempt, while the mountainous portions of the country seem to be especially favourable for the development of these storms, which, however, is true also of the other summer months.

THE HOTTEST REGION IN THE UNITED STATES.—Mr. G. H. Willson, in *The Monthly Weather Review*, says that it has long been believed that the hottest place in the United States was in one of those depressions below sea-level in South-eastern California, Death Valley, or the Salton Sea Country. Until June, 1911, there was only a short record from Death Valley, but there were many long and reliable records from the latter which showed extremely high temperatures; therefore the Salton Sea Country was generally considered to be the hottest place in the United States. It will no doubt surprise many persons to learn that not only the highest temperature in the United States occurred in Death Valley, but that the highest shade temperature ever recorded in the open air with standard instruments and under approved methods of exposure in any portion of the world was recorded at Greenland ranch, on the edge of Death Valley, Inyo County, California, on July 10th, 1913, when the thermometer registered 134° F. In fact, the record from this station for the period from July 8th to 14th, 1913, inclusive, is probably the most remarkable authentic record of high-shade temperature ever made. The daily maxima during this intensely hot spell were: 8th, 128°; 9th, 129°; 10th, 134°; 11th, 129°; 12th, 130°; 13th, 131°; and 14th, 127°. During this time the temperature never fell below 85°.

The thermometers are mounted in a screen of the regulation pattern, with lowered sides and a double roof. The location for the instruments was carefully selected, the screen being placed over an alfalfa sod, and about fifty feet from the nearest high object. Mr. Willson states that the location is such that the screen is not exposed to the reflected heat from the desert.

CLIMATE AND ARCHITECTURE.—Architecture is affected by many influences, amongst which are race, climate, materials, religion, and social conditions. An interesting article on this subject appeared in a recent issue of *The Builder*, in which it was shown that climate is the principal factor that determines the type of roof and window of any building. The former is the more important, for the history of architecture is very largely the history of roofing. A climate such as that of Egypt, which is very hot, with a slight rainfall, results in the use of a flat roof, the simplest method of protecting a building from heat. The exclusion of wet being of secondary importance, a sloping roof becomes unnecessary. To obtain light only small openings are used, it being natural in a hot and very sunny climate to prefer a dim light as a relief from the outside glare. The flat roof also affords pleasant sleeping spaces during hot weather. Greece and Italy have brilliant sunshine and less heat, but more rain to contend with than Egypt. The consequence is that the slightly sloping roof, by means of which rain-water is conveyed from the building, becomes a necessity. The slope adopted for the roof settled the proportion of the pediments. The natural method of excluding wet from a building with a pitched roof is to make the roof plane advance beyond the external face of the wall, thus covering the joint between the roof and the wall. As a result, we obtain the cornice, which may be said to spring out of an absolute constructive necessity. In northern countries, where there is more rain and occasional snow, steeper roofs are advisable, with ordinary building materials, than those used in Greek and Roman buildings. Windows are larger, and details, to be satisfactory, must be bolder.

RAINFALL IN JAVA.—A valuable work has been published by the Royal Magnetical and Meteorological Observatory at Batavia on the results of rainfall observations made in Java during the period 1879–1911. This is based on the observations from one thousand and sixty-one

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which stations have records extending over more than five years. Tables are given showing the mean monthly amount, the mean maximum amount in twenty-four hours, and the mean monthly number of rain days. The work is accompanied by an atlas, containing seasonal maps, showing the distribution of rainfall over Java during the west monsoon (December–February); the east monsoon (July–September); and the seasons of transition, viz., October–November, March–April, and May–June. The average yearly rainfall varies from 326 inches at Kranggan, Banjoemas, to thirty-four inches at Sirah Kentjong, Kediri; and the heaviest fall in twenty-four hours was 20·12 inches at Besokor, Semarang, on January 31st, 1901.

MICROSCOPY.

By F.R.M.S.

A METHOD OF COMPUTING MAGNIFICATIONS FOR PHOTO-MICROGRAPHERS.—It is desirable for the photo-micrographer to have some nearly accurate means of measuring the magnification of the object which his photograph records. The words "nearly accurate" are used for the reason that the calibration of the stage micrometers, in general use, leaves much to be desired. The whole question of magnifications is founded on the properties of similar triangles. Consequently, instead of measuring, by means of the micrometer, each individual attempt, it is only necessary to measure what may be called "a standard magnification" for each objective, if used alone; and for each objective and eyepiece combined at a definite tube length. For purposes of simplicity in calculation, this standard length is usually ten inches. Perhaps, if the writer's method of procedure be given, matters may be simplified.

First, then, a piece of thin celluloid is taken, three inches long by half an inch wide. This is superimposed over a rule, graduated in twentieths of an inch, and the graduations are scratched as accurately as possible on the edge, each tenth of an inch being marked by a longer scratch, and the tenths marked in Roman numerals to avoid curved figures. For convenience, the zero on the scale is at a distance of one inch from either end. The objective to be measured is screwed in place, and the tube extended to ten inches. In the case where this is not feasible the ground-glass of the camera is brought to a point ten inches from the shoulder of the objective by pushing the tube of the microscope into the opening in front of the camera. The stage micrometer being in place, the celluloid scale, supported on *the back* by a microscope glass slip, is placed against the open end of the tube, and the divisions on the micrometer are brought into sharp focus, using a magnifying focusing lens, previously focused on the scale. In the case of the camera ground-glass being used, a proper adjustment of the distance of ten inches is now made. The interval between any two lines of the micrometer, as seen on the celluloid scale, is noted, and the micrometer moved so as to present another interval between two lines, and this is similarly noted. It is well to measure in this way three or four intervals, and take the mean reading. Thus, so many twentieths of an inch represent 1/100th or 1/1000th, as the case may be. If $\frac{x}{20}$ represent $\frac{1}{100}$, then the magnification is given by $\frac{x}{20}$ divided by $\frac{1}{100}$, or $\frac{100x}{20}$. An example may simplify matters. Using a quarter-inch objective, it was found that $\frac{9}{20}$ represented $\frac{1}{100}$. Therefore the magnification was $\frac{900}{20} = 45$. Incidentally, this shows that the focal length of the objective was not a quarter-inch, but $\frac{10}{45}$ inch, or $\frac{2}{9}$ths. Similar measurements are taken for other objectives, and the magnifications for any distance D between shoulder of objective and ground-glass is given by $\frac{D}{10} \times$ magnification at ten inches. Thus, in the above case of the so-called quarter-inch, suppose the camera extension, plus length of tube (*i.e.*, ground-glass to shoulder of objective), is twenty-two inches, the magnification is $\frac{22}{10} \times 45 = 99$. It is important to make these tests of each lens, as one cannot expect every objective issued by, even the best, makers to be of identical focal length, and consequently the tables of magnifications issued in their lists cannot be correct for every objective sold.

A reference to Figure 99 will make all clear. O is the object; AS the microscope tube; AB the magnification at ten inches; (SO_1), A′B′, A″B″, and so on, magnifications at greater distances SO_2, SO_3, and so on. It is obvious that $AB : A'B' :: SO_1 : SO_2$.

$$\therefore A'B' = \frac{AB \times SO_2}{SO_1}$$

i.e., if D be the distance, m the initial magnification of the objective at ten inches, and M the required magnification, then $M = \frac{D}{10} \times m$.

A table of magnifications can be readily calculated for any distances. When, however, an eyepiece is used a rather different course must be followed, although the same general principles hold. But in this case tube-length has an important bearing. Here the point, from which measurements are made, is the eye-point of the ocular, known as the "Ramsden circle or disc." The position of this circle varies with the N.A. of the objective and magnifying power of the eyepiece, being farther from the eye lens of the ocular, with low N.A. and low magnification, and *vice versa*. However, for our purpose a point between five and ten millimetres, say a quarter-inch, will be sufficiently near the true position.

Referring to Figure 101, E is the cap of the eyepiece; RC the position of the Ramsden circle; AB the image of the object as seen through the eyepiece; A′B′, A″B″, and so on, enlarged images at distance PO_1, PO_2, and so on.

To obtain our data of magnifications, let the tube-length be ten inches as before, and the eyepiece and objective in position. The camera extension is to be ten inches, and one or more intervals on the micrometer sharply focused on the ground-glass. The celluloid scale is applied to the glass and readings taken as before. The camera extension is a matter of some nicety of adjustment, as the zero of the scale of camera extension must be vertically under the Ramsden circle, or at least the position which we assign to it. Figure 100 shows the method of adjustment. H is the hood on the camera front; EP the eyepiece; P a point quarter-inch from the eye *lens* surface, and vertically above O, the zero of the scale of camera extension. With matters duly adjusted, the three or four readings are taken as before, and the magnification noted for that objective and eyepiece. Similar notes are made for the same objective with other eyepieces, and a table can easily be constructed of magnifications for various distances. An example may be of assistance. The writer has a series of eyepieces, made by the same makers as the objective—a rather important point from an optical point of view—and of nominal magnifying powers of 5, 7, 10, and 14.

We may take them for the purpose of illustration in conjunction with a two-inch objective. Tube-length, ten inches; distance to ground-glass from zero of scale, ten inches.

Eye-piece						
5	gave	$\frac{17\frac{1}{4}}{20}$	for	$\frac{3}{100}$	magnification	$\frac{17{\cdot}25}{20} \times \frac{100}{3} = 28{\cdot}75$
7	,,	$\frac{15\frac{1}{4}}{20}$	,,	$\frac{2}{100}$	,,	$\frac{15{\cdot}25}{20} \times \frac{100}{2} = 38{\cdot}125$
10	,,	$\frac{12{\cdot}5}{20}$	,,	$\frac{1}{100}$	,,	$\frac{12{\cdot}5}{20} \times 100 = 62{\cdot}5$
14	,,	$\frac{20{\cdot}5}{20}$	,,	$\frac{1}{100}$	,,	$\frac{20{\cdot}5}{20} \times 100 = 102{\cdot}5$

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Having these data, we proceed to construct our table of magnifications. Two-inch objective; tube-length, ten inches.

Distance in inches.	5	7	10	14
8	23	30·5	50	82
9	25·875	34·3125	56·25	92·25
10	28·75	38·125	62·5	102·5
11	31·625	41·9275	68·75	112·75
12	34·5	45·75	75	123
13	37·375	49·5625	81·25	133·25
14	40·25	53·375	87·5	143·5
15	43·125	57·1875	93·75	153·75
16	46	61	100	164
17	48·875	64·8125	106·25	174·25
18	51·75	68·625	112·5	184·5
19	54·625	72·4375	118·75	194·75
20	57·5	76·25	125	205

Dividing by 10 we get the magnification for one inch; and by addition or subtraction we easily get our magnifications for any distance in inches. Of course, for ordinary purposes, the decimals may be discarded, and the nearest integer taken. Thus 25·875 may be taken as 26, and 43·125 taken as 43.

Now all microscopes do not have a tube which will extend to ten inches. In fact, such a tube-length is seldom used, since most objectives at the present time are corrected for a tube-length of eight inches. The writer invariably uses a Davis-Shutter of length $\frac{9}{16}$inch, and a tube-length of 7·8 inches, making in all 8·3625 inches. The difficulty is easily surmounted for any tube-length, provided correct observations are first secured. The following formula will solve the whole question :—

Let M be the magnification required.
" T the tube-length at which the required magnification is taken.
" t the tube-length at which the observations have been taken.
" m the magnification recorded at tube-length t and distance d.
" D the distance of ground-glass from Ramsden circle for required magnification.
" d the distance of ground-glass from Ramsden circle at which the record was taken.

$$\text{Then} \frac{T}{t} \times \frac{D}{d} \times m = M.$$

So that, if t be ten inches and d be ten inches,

$$M = \frac{T}{10} \times \frac{D}{10} \times m.$$

Again, if t be eight inches and d be ten inches, and m' the recorded magnification.

$$M = \frac{T}{8} \times \frac{D}{10} \times m'.$$

As before stated, it is better for easy calculation to make the initial records at a camera distance (d) of ten inches. For microscopes with draw-tubes too short to attain a ten-inch length, a method for obtaining the focal length of an objective, described by Dr. E. J. Spitta in his "Microscopy," is of great value. He postulates the use of a Ramsden eyepiece, or a Huyghenian one, with the field lens removed. In the method, described earlier in this article, of using a focusing glass—provided it possesses two lenses with convex surfaces *towards* each other—and the celluloid scale with glass slip interposed, we have, to all intents and purposes, a Ramsden eyepiece and ruling complete. With this arrangement, therefore, two measurements, m_0 and m_1, are taken with two tube-lengths, L_1 and L_0. The focus F of the objective is then measured by dividing the difference of tube-lengths employed by the difference of magnification experimentally found.

$$\text{Thus } F = \frac{L_1 - L_0}{m_1 - m_0}.$$

Dividing F into 10 inches $\left(\frac{10}{F}\right)$ gives the initial magnification of the objective at a distance of 10 inches.

We have remarked on the fact that objectives are rarely of the focal length marked on them. Far greater is the divergence in this respect with eyepieces, and here surely the makers could remedy matters, and mark their eyepieces with more exactitude. In the small table of magnifications of the two-inch objective it is noticeable that 5, 7, 10, 14 eyepieces give, at the same distance and with the same objective, readings of 23, 30·5, 50, 82. Now 10 is twice 5, but twice 23 is not 50; and 14 is twice 7, but twice 30·5 is not 82. As a matter of fact, it is found that the magnifications are somewhat as follows :—

5 is 5·27
7 ,, 7·97
10 ,, 11·46
14 ,, 18·8 ! !

Moreover these eyepieces are capable of being used with apochromatic and holoscopic objectives by drawing out the eye lens on a graduated sleeve. Allowance must be made for this extension, and possibly when so drawn out their magnifying powers are nearer their marked numbers.

These results emphasise the importance of recording the focal lengths and magnifying powers of both objectives and eyepieces, if anything like accurate dimensions are to be assigned to photo-micrographs.

G. ARDASEER,
Past President of Photo-micrographical Society.

PHOTOGRAPHY.

By EDGAR SENIOR.

SULPHIDE TONING FOR LANTERN SLIDES.—When it is desired to convert the black image obtained on an ordinary lantern plate into one of a brown, black, or sepia colour this may be readily accomplished by the same means that is employed in toning bromide prints, as, generally speaking, the methods that are used in the one case are equally applicable in the other. In order, however, to ensure success in the process, the exposure and development must be so adjusted that an image full of vigour results, as a poor, thin slide is practically useless for toning.

For the first stage in the toning process the following solution may be employed :—

Potassium ferricyanide	...	...	10 grains
Potassium bromide	...	...	15 ,,
Water	...	...	1 ounce

This keeps well, and may be used over and over again. The slide, which has been thoroughly washed after fixing, is dried, and then placed in the solution until the image is completely bleached through to the glass, after which it is washed for about five minutes, and then immersed in a solution of soda sulphide of the following strength :—

Sodium sulphide (recryst)	...	...	10 grains
Water	...	...	1 ounce

In this solution the toning takes place rapidly, but the slide must be left in until the action has extended through the darkest parts, when the image is washed for about fifteen minutes in running water, and then dried. In place of the potassium ferricyanide and bromide we may employ a solution of iodine in potassium iodide as originally recommended by Mr. Blake Smith for the bleaching agent: it gives equally good results, although in our experience there is no advantage attending its use. For those, however,

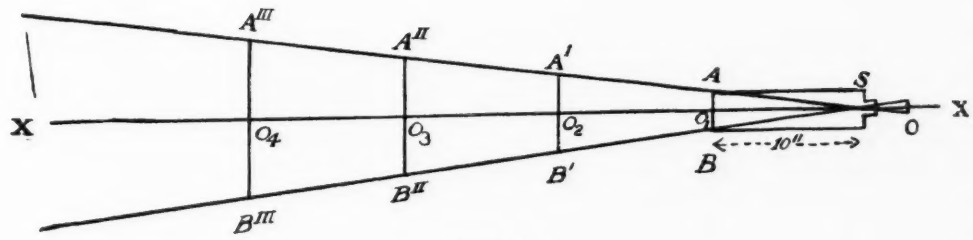

FIGURE 99.

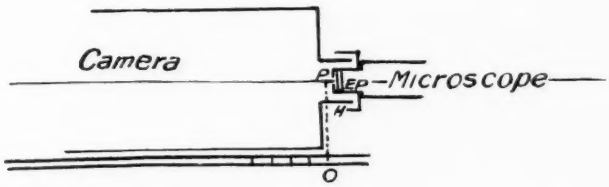

FIGURE 100.

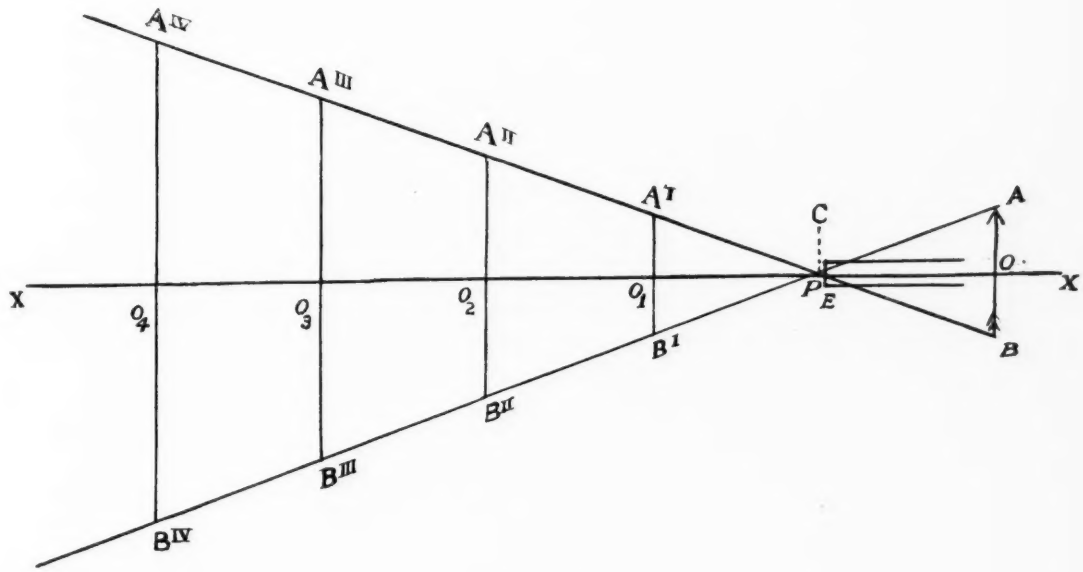

FIGURE 101.

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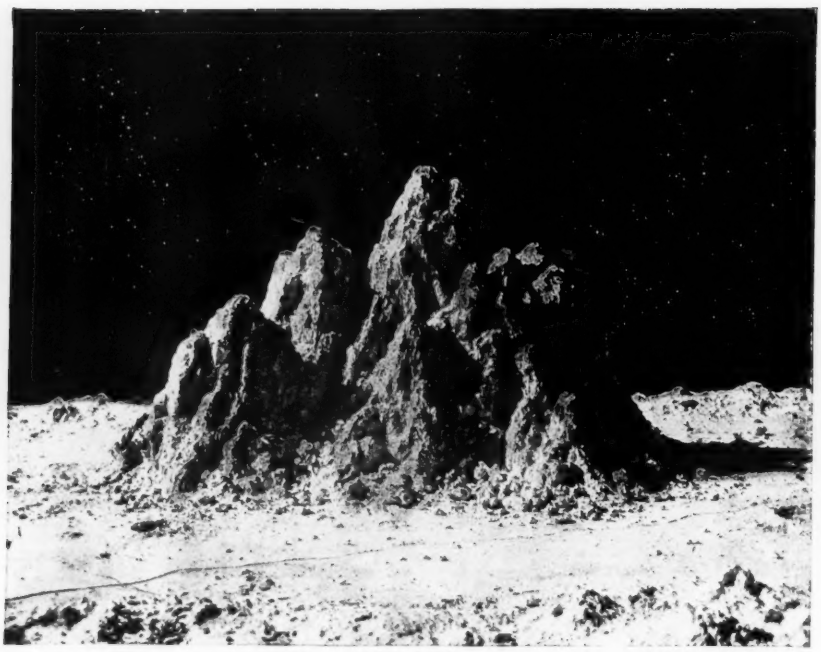

FIGURE 102.
An ideal picture of the Lunar Mountain "Pico" as it would probably appear to an observer located on the Moon.

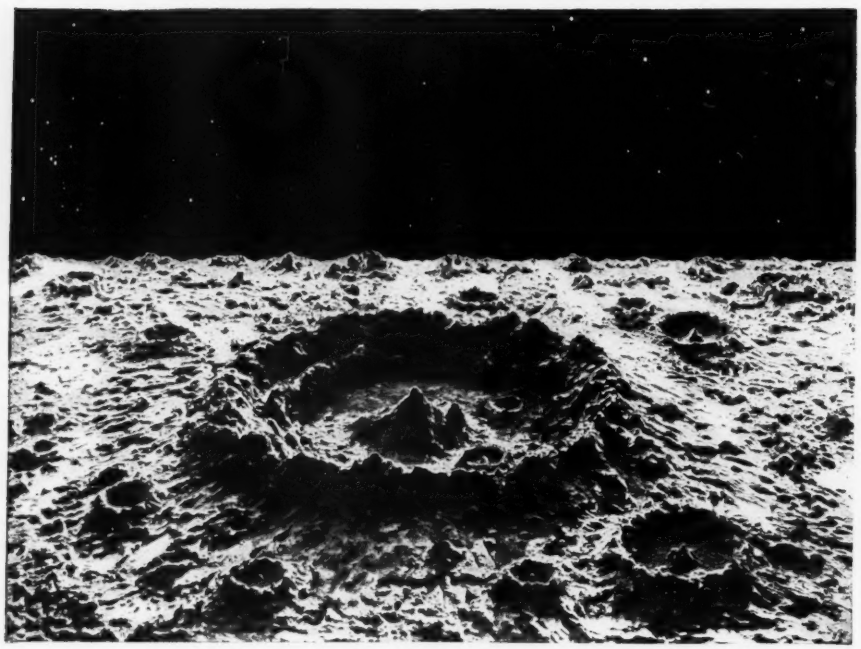

FIGURE 103.
A normal Lunar Crater.

From "The Moon as a Planet, a World, and a Satellite," by the courtesy of Mr. John Murray.

(See Page 111.)

who desire to try it, the following is the formula given by the inventor :—

Potassium iodide	110 grains
Iodine	45 ,,
Water	10 ounces

Lantern slides may also be toned in the " hypo " and alum bath used for bromide prints. When this method of toning is adopted, however, it is necessary to first harden the gelatine film. This is most conveniently done by means of a formalin bath of the following strength :—

Formalin	1 ounce
Water	10 ounces

the slide being allowed to remain in this solution for five minutes, after which it is rinsed and dried. For the purpose of toning the following solution must be prepared :—

" Hypo "	700 grains
Alum (powdered)	70 ,,
Water (hot)	10 ounces

The " hypo " is first dissolved, and then the alum added in small quantities at a time until the whole is introduced, when the solution will be milk-white. This bath must not be filtered, and it improves by being kept for a few days before use. It is a good plan to leave a spoilt slide in it, as this prevents to a great extent a reducing action being set up in the slides that are subsequently toned in it. For toning the slides are placed with the solution in an enamelled iron dish, and the whole is then gradually heated to a temperature of about 140° F. The image will then tone in about thirty minutes to a rich brown colour. The toning being complete, the slide is well rinsed in cold water and the surface of the film gently rubbed over with cotton-wool, in order to remove any deposit of sulphur that may be there. Apart from the pleasant change of colour imparted to the image by these methods of toning, there is the added advantage of its greater permanence, since the sulphide of silver, which constitutes the product of the reaction, is itself a very stable substance. The chief objection perhaps to any of these methods of toning is that practically only one colour is obtainable, and where variations in tone are required other methods must be employed to produce them.

PHYSICS.

By J. H. VINCENT, M.A., D.Sc., A.R.C.S.

ALTITUDES OF AURORAE.—In a letter to *Nature* (March 2nd, 1916) Störmer gives a diagram showing the altitude of aurora borealis seen from Bossekop (Norway) during the spring of 1913. The results are computed from simultaneous photographs taken from stations twenty-seven kilometres apart, and give the results from thousands of observations. The heights vary from eighty-six to one hundred and eighty kilometres, but by far the majority of the observed heights lie in the neighbourhood of one hundred and five kilometres.

TARGETS FOR *X*-RAY TUBES.—The anticathode or target of an *x*-ray tube is the source of the *x* radiation, due to bombardment by the kathode rays. For short exposures the current must be great, and the target must be capable of standing very high temperatures. Tungsten is particularly suitable for the purpose. It melts at about 3000° C., whereas platinum, which was used in the earlier tubes, melts at 1750° C. The British Thomson-Houston Company, Ltd., has introduced a special target of this metal that is being largely used by manufacturers of *x*-ray tubes. The tungsten is in the form of a thick button, brazed into a solid block of copper, in some cases weighing as much as half a pound. This forms a lasting and efficient target, even when heavy currents are used for considerable periods of time. The adaptation of tungsten for this purpose is an example of the great value that lies hidden in the rare and little-known elements, and doubtless other instances of a similar nature will develop as the metals become available. (Gardiner, *Journal of the Röntgen Society*, No. 24, Vol. VI.)

COMPLETE PHOTO-ELECTRIC EMISSION.—When light of short wave-length falls on a metal it causes an emission of electrons. All bodies emit light when raised to a sufficiently high temperature, so that an emission of electrons will occur from a glowing body due to its own light. This emission of electrons is called the " complete photo-electric emission," as it is excited by the complete radiation with which the material is in equilibrium at the temperature under consideration. This emission of electrons will form part of the thermionic current, and it is of interest to find out whether it forms any considerable fraction of the observed effects. Theory indicates that the purely thermionic current and the photo-electric current vary with the temperature in the same way, and experiments with platinum show that the thermionic current is always thousands of times greater than the complete photo-electric emission. (Richardson, *Phil. Mag.*, February, 1916.)

RADIO-ACTIVITY.

By ALEXANDER FLECK, D.Sc.

A COMPOUND OF POLONIUM AND HYDROGEN.—Mr. R. W. Lawson was in Austria when war broke out; but, although he is not allowed to leave that country, he enjoys a large measure of liberty, and is still able to prosecute his research work at the Radium Institute in Vienna. In a recent number of the *Monatshefte* he has published a paper on the above subject.

It was found that when a film of polonium was kept in a vessel filled with hydrogen the number of ions at any given distance from the film gradually increased as time progressed. This phenomenon can be explained most easily on the assumption that hydrogen and polonium slowly enter into combination to form a compound. If this compound is a gas, it will diffuse throughout the whole of the containing space, and consequently the ionisation at a given distance will be increased owing to the greater propinquity of a number of disintegrating atoms.

This explanation seems to be entirely reasonable, as polonium is the fifth member of the oxygen, sulphur, selenium, tellurium group, of which each element readily forms a gaseous compound with hydrogen.

LONG-RANGE α PARTICLES.—A paper is published, in the April issue of *The Philosophical Magazine*, by Sir E. Rutherford and Mr. A. B. Wood, giving a preliminary account of some experiments in which α rays, possessing very long ranges, were observed. These rays came from the active deposit of thorium, and their origin is thought to be the element thorium-C. The most penetrating α particle hitherto known comes from thorium-C., and has a range of 8·6 centimetres through air at seven hundred and sixty millimetres pressure and at 15° C.; but the authors have found evidence of a few α particles having a range of 10·2 centimetres, and of a still fewer number having a range of 11·3 centimetres. By the method of counting scintillations, it was calculated that one atom in ten thousand of thorium-C gives out one or other of these long-range α rays.

It is well established that thorium-C has the choice of disintegrating in at least two ways, thirty-five per cent. of the atoms going one way and sixty-five per cent. the other. The explanation that the authors put forward of the existence of these long-range α particles is that thorium-C atoms have the choice of disintegrating in either of four ways, although very few atoms—only one in ten thousand—undergo the mode which gives these long-ranged α particles. If this explanation is correct, it complicates very largely the possibilities of the number of radio-active elements capable of formation, although theoretically it should be

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quite as easy to explain the mechanism of formation of four branch products as to give the explanation for two branch products.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.

GIANT TADPOLES.—The tadpole of *Calyptocephalus gayi*, a giant water-frog of Chile, reaches a length of six inches, which is almost as much as that of the adult frog, whose measurement is six to seven inches from snout to vent. A well-known but very striking case is the tadpole of *Pseudis paradoxa*; also a water frog of the Guyanas, which has been known to attain a length of ten and one-third inches. Of this total three and one-third inches, we read, is taken up by the head and body, which leaves six and two-third inches for the thick muscular tail, which is almost four inches in width. It is extraordinary to find half of the total devoted to a larval locomotor organ, and the extraordinariness grows when we learn that the adult frog measures only two to two and a half inches from snout to vent.

AUTUMN MIGRATION OF SALMON.—In the Aven, a river in Brittany, Professor L. Roule has studied the autumnal movements of the salmon coming up stream to spawn. As in his previous investigations, he finds that the movement, both in estuary and river, is always towards the more abundantly oxygenated water. A practical conclusion is suggested that in selecting rivers for repeopling experiments a preference should be given to those richly aërated and allowing of vigorous respiration.

INTERESTING FROGS AND TOADS. — Richard Deckert reports on some frogs and toads from Costa Rica and New South Wales, and depicts some of them in colour in a very charming way (Scientific Contributions of the New York Zoölogical Society, 1915). The Costa Rica forms include the "marine toad" (*Bufo marinus*), which may be eight and a half inches long, and will tackle a very young mouse. The breeding call of the male is said to resemble the barking of a dog. The ornate frog or harlequin frog (*Dendrobates tinctorius*) has an extraordinary livery of bright emerald green and black; another species (*D. typographus*) is even more daring in its colours, brilliant red above with bright blue limbs. In this genus the poisonous secretion of the skin is unusually virulent. Mr. Deckert notes that the ornate frog "does not always hop, but will often elevate its body on its long slender legs, and stalk around as though walking on stilts." There are many reasons, we think, to justify the belief that the race of amphibians has always been strong on the experimental side. One may refer, for instance, to the variety of their devices for the safeguarding of the eggs, to the variety of their modes of respiration, or to the numerous new acquisitions they made—fingers and toes, true lungs, vocal cords, movable tongue, and so forth.

Among the Australian forms that Mr. Deckert discusses we may notice the gold tree toad, or "bell frog" (*Hyla aurea*), a large gorgeously coloured, greedy creature, which the Bushmen are fond of; and the phlegmatic "White's tree toad" (*Hyla coerulea*), which has a highly developed sense of locality, returning again and again to the same spot for basking or sleeping.

On the common "Australian toad" (*Pseudophryne australis*) some interesting observations have been made. Thus, as regards hunting, "instead of hopping they slowly and deliberately creep up to their intended prey, moving each arm and leg separately, first an arm, then the leg of the opposite side, then the other arm, and lastly the other leg, giving the whole movement a singular mechanical appearance. When about a half-inch from the insect the tongue shoots forth with lightning-like speed, and the insect vanishes. The toad retains its seemingly strained position until another victim is sighted, when the whole manœuvre is repeated. When disturbed, however, these toads hop in ordinary fashion."

We have from time to time in these zoölogical notes given some prominence to amphibians, and we do so again without apology; for we are convinced that these cold-blooded, yea-and-nay, phlegmatic but experimental, wait-and-see creatures have many secrets to tell us.

ON *SERGESTES PREHENSILIS* (BATE) AND THE PENAEIDAE OF JAPAN, BY K. NAKAZAWA.

In forwarding his Japanese treatise, the author obligingly enclosed the following brief summary of its contents, written in English. For readers of "KNOWLEDGE," interested in the subject, but unacquainted with the writer's native tongue, this should be a welcome supplement to the numerous figures which speak a language intelligible to all but the blind.

"SUISAN KOSHUJIO.
(The Imperial Fisheries Institute.)
Tokio, 19 .

ETCHUJIMA, FUKAGAWA, TOKIO, JAPAN.

Contents.

1.—Report on the *Sergestes* of the Bay of Suruga, Japan. Important points written in this article as follows :—

'Specific name *Sergestes prehensilis*, Sp. Bate.
'Abundantly caught by fishermen. Total amount annually 'fished reaches to 10 million pounds in weight, and about 'to a half million yen in value. All the products are boiled 'and dried quickly after fished. They are eaten by us as 'a delicate food and also exported to China and other 'countries.

'*Habits.*—At day this animal lives on the bottom and 'feeds on mud, that is, on the microorganisms and organic 'substance contained in mud; at dark night it comes to 'the middle of the water in winter or near the surface 'after May; fishermen then collect the great mass of this 'animal by a large tow net, as figured in this paper, managed 'by two boats, with about ten fishermen on each boat; 'in that case the net falls down from 50 to 100 fathoms.

'Fishing-place about one or two miles apart from the 'shore near the famous Mount Fugi.

'*Development.*—Very interesting to science; in summer, 'from June to August, the ovaries of the females turn to 'greenish-grey colour, the eggs of that colour are deposited 'floating in the water, more numerous in deeper water; 'they hatch out as nauplius; metamorphosis passes 'very complex stages, you see several figures of them in 'this paper.'

2.—Second Report on the Japanese eatable Shrimp and Crabs *Penaeidae*.

Notes.—Each page with one species.

3.—Investigations of the Inland Sea of Japan.

'Above three reports were written by K. Nakazawa.'"

It may be of interest to mention that the species *Sergestes prehensilis* (Spence Bate) was first described in 1881, figured and again described by Bate in 1888, and a third time described, with fresh figures, by H. J. Hansen in 1903, but in all cases from a single specimen which H.M.S. "Challenger" had procured off Japan out of a supposed depth of seven hundred and seventy-five fathoms.

T. R. R. STEBBING.

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THE FACE OF THE SKY FOR JUNE.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 24.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Mars. R.A.	Mars. Dec.	Jupiter. R.A.	Jupiter. Dec.	Uranus. R.A.	Uranus. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°
June 4	4 48·5	N. 22·4	7 42·8	N. 21·9	4 59·6	N. 20·3	7 21·9	N. 24·3	10 22·6	N. 11·5	1 38·4	N. 9·0	21 29·2	S. 15·6
„ 9	5 9·1	22·9	11 31·8	S. 1·5	4 48·7	18·9	7 25·7	23·5	10 31·9	10·5	1 42·1	9·3	21 29·0	15·6
„ 14	5 29·8	23·3	16 1·4	S. 25·1	4 40·9	17·9	7 25·4	22·6	10 41·4	9·4	1 45·6	9·7	21 28·7	15·6
„ 19	5 50·6	23·4	21 20·5	S. 13·8	4 39·5	17·8	7 20·8	21·8	10 51·1	8·4	1 49·1	10·0	21 28·4	15·7
„ 24	6 11·4	23·4	1 28·9	N. 14·9	4 45·6	18·3	7 12·1	20·9	11 1·0	7·3	1 52·4	10·3	21 28·0	15·7
„ 29	6 32·1	N. 23·2	5 47·0	N. 26·2	4 59·8	N 18·4	7 0·3	N. 20·0	11 11·0	N. 6·1	1 55·5	N. 10·5	21 27·5	S. 15·8

TABLE 25.

Date.	Greenwich Noon. Sun. P	Sun. B	Sun. L	Mars.	Mars. P	Mars. B	Mars. L	Mars. T	Jupiter.	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2	Midnight. Moon. P
	°	°	°		°	°	°	h. m.		°	°	°	°	h. m.	h. m.	°
June 4 ...	−14·3	−0·1	68·8	June 5 ...	+11·5	+22·3	345·7	0 59 *e*	June 5 ...	−22·6	+2·8	332·2	294·5	2 54 *m*	3 52 *m*	June 4	+10·6
„ 9 ...	12·3	+0·5	2·7	„ 11 ...	13·2	22·9	287·7	4 57 *e*	„ 12 ...	22·3	2·8	356·6	265·4	2 14 *m*	4 40 *m*	„ 9	+22·7
„ 14 ...	10·2	1·1	296·5	„ 17 ...	15·0	23·5	229·6	8 56 *e*	„ 19 ...	22·0	2·9	21·1	236·5	1 34 *m*	5 28 *m*	„ 14	+ 9·4
„ 19 ...	8·0	1·7	230·3	„ 23 ...	16·8	23·9	171·4	0 15 *m*	„ 26 ...	−21·8	+2·9	45·6	207·6	0 54 *m*	6 16 *m*	„ 19	− 18·1
„ 24 ...	5·8	2·2	164·1	„ 29 ...	+18·7	+24·3	113·1	4 15 *m*								„ 24	−20·7
„ 29 ...	− 3·5	+2·8	97·9													„ 29	− 0·1

P is the position angle of the North end of the body's axis measured eastward from the North point of the disc. B, L are the helio-(planeto-) graphical latitude and longitude of the centre of the disc. T is the time of transit of the zero meridian across the centre of the disc. In the case of Jupiter, System I refers to the rapidly rotating equatorial zone; System II to the temperate zones which rotate more slowly. To find intermediate passages of the zero meridian of either system across the centre of the disc, apply to T_1 T_2 multiples of $9^h\ 50^m{\cdot}6$, $9^h\ 55^m{\cdot}8$ respectively. In the case of Mars apply multiples of $24^h\ 40^m$.

The data for the Moon in Table 28 are given for Greenwich midnight, *i.e.*, the midnight at the end of the given day. Those for the planets were given for midnight last year, but are now given for Noon.

The letters *m*, *e* stand for morning, evening. The day is taken as beginning at midnight.

THE SUN is moving Northward till $21^d\ 6^h\ 24^m\ e$, when the Summer Solstice is reached. Its semi-diameter diminishes from 15′ 48″ to 15′ 45″. Sunrise changes from $3^h\ 52^m$ to $3^h\ 49^m$; sunset from $8^h\ 4^m$ to $8^h\ 18^m$. There is now considerable solar activity, and a constant watch should be kept on the disc.

ANNULAR ECLIPSE OF SUN, JULY 30TH.—Particulars of this eclipse are given now, in the hope of reaching our Australian readers in time. The central line crosses Australia and Tasmania, annularity being visible at Adelaide and near Melbourne, the Sun being near the meridian. The following are points on the central line: Long. 114° E., Lat. 23° 27′ S.; 119° E., 23° 44′ S.; 124° E., 24° 49′ S.; 129° E., 26° 58′ S.; 134° E., 30° 16′ S.; 139° E., 34° 26′ S.; 144° E., 39° 2′ S.; 149° E., 43° 41′ S. Duration of annularity six minutes. Partial eclipse is visible in Malay Peninsula and Archipelago, part of Philippines, New Zealand, East Indian Ocean, South West Pacific Ocean.

MERCURY is an evening Star till the 6th, when it passes Inferior Conjunction and becomes a morning star; but, being south of the Sun, it is unfavourably placed for Northern observers. It reaches elongation 22° West of Sun on 30th. Semi-diameter diminishes from 6″ to 4″. Illumination, almost zero at conjunction, one-third on 29th.

VENUS is an evening star, stationary on 11th. It is approaching Inferior Conjunction, which is reached on July 3rd. The semi-diameter increases from 21″ to 30″ (its maximum value). The crescent is narrowing. Its greatest width is 8″ on 4th, 4″ on 19th, ¼″ on 29th. A series of good micrometer measures of the distance between the horns on several days near Inferior Conjunction would be of value.

THE MOON.—First quarter $8^d\ 11^h\ 59^m\ e$; Full $15^d\ 9^h\ 42^m\ e$; Last quarter $22^d\ 1^h\ 16^m\ e$. New $30^d\ 10^h\ 43^m\ m$. Apogee $3^d\ 9^h\ e$. Perigee $16^d\ 3^h\ e$. Semi-diameter 14′ 45″, 16′ 43″ respectively. Maximum librations 10^d 8° E., 12^d 7° N., 23^d 7° W., 24^d 7° S. The letters indicate the region of the Moon's limb brought into view by libration. E., W. are with reference to our sky, not as they would appear to an observer on the Moon. (See Table 25.) Attention is called to the fact that Full Moon occurs when the Moon is unusually near the Earth.

MARS is advancing, with increased speed, in Leo. It will soon become too distant from the Earth for useful observation. Semi-diameter 3¼″. Defect of illumination 0″·7. The North Pole of the planet is now turned towards the Earth and Sun. The planet is in the part of its orbit that corresponds with the first half of July on Earth. The Summer Solstice of Mars' Northern Hemisphere was passed on May 6th.

JUPITER is a morning star in Aries. Equatorial diameter 37″, Polar 35″.

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TABLE 26. LONG-PERIOD VARIABLE STARS.

Star.	Right Ascension.	Declination.	Magnitudes.	Period.	Date of Maximum.
	h. m. s.	° ′		d.	
R X Cephei	0 43 9	+81 30	7·4 to 7·9	130	1916—June 26
T Ursae Maj.	12 32 33	+59 57	5·5 to 12·7	257	,, June 28
V Boötis	14 26 19	+39 14	6·4 to 11·3	259	,, June 22
R S Herculis	17 18 9	+23 0	7·5 to 12·8	220	,, June 14
T Herculis	18 5 53	+31 0	6·9 to 13·3	165	,, June 29

Minima of Algol $14^d\ 0^h\cdot9\ m$, $16^d\ 9^h\cdot7\ e$, $19^d\ 6^h\cdot5\ e$, July 4th, $2^h\cdot4\ m$. Period $2^d\ 20^h\ 48^m\cdot9$.

Principal Minima of β Lyrae $9^d\ 4^h\cdot9\ m$, $22^d\ 3^h\cdot0\ m$. Period $12^d\ 22^h\cdot1$.

Configuration of satellites at $2^h\ 30^m$ *m* for an inverting telescope.

JUPITER'S SATELLITES.

Day.	West.	East.	Day.	West.	East.
June 1	42 ○	13	June 16	421 ⊙	
,, 2	42¼ ○		,, 17	43 ○	1
,, 3	34 ○	12	,, 18	431 ○	2
,, 4	3 ○	42 1●	,, 19	432 ⊙	
,, 5	231 ○	4	,, 20	¾ ○	13
,, 6	2 ○	134	,, 21	1 ○	423
,, 7	1 ○	234	,, 22	○	21¾
,, 8	⊙	134	,, 23	21 ○	34
,, 9	213 ○	4	,, 24	3 ○	14 2●
,, 10	3 ○	124	,, 25	31 ○	24
,, 11	3 ○	24 1●	,, 26	32 ○	14
,, 12	23 ○	4	,, 27	2 ○	34 1●
,, 13	42 ○	13	,, 28	1 ○	243
,, 14	41 ○	23	,, 29	○	4¾3
,, 15	4 ○	213	,, 30	421 ○	3

The following satellite phenomena are visible at Greenwich, all in the morning hours:—$3^d\ 3^h\ 12^m$ I. Sh. I.; $4^d\ 3^h\ 32^m$ I. Oc. R.; $5^d\ 3^h\ 44^m\ 47^s$ III. Ec. D., $8^d\ 3^h\ 2^m$ II. Tr. E.; $11^d\ 2^h\ 13^m\ 55^s$ I. Ec. D.; $12^d\ 1^h\ 46^m$ I. Sh. E., $2^h\ 52^m$ I. Tr. E.; $15^d\ 3^h\ 11^m$ II. Tr. I., $3^h\ 30^m$ II. Sh. E.; $16^d\ 2^h\ 43^m$ III. Tr. I.; $19^d\ 1^h\ 30^m$ I. Sh. I., $2^h\ 41^m$ I. Tr. I., $3^h\ 40^m$ I. Sh. E.; $20^d\ 2^h\ 0^m$ I. Oc. R.; $22^d\ 3^h\ 29^m$ II. Sh. I.; $23^d\ 1^h\ 57^m$ III. Sh. I.; $24^d\ 3^h\ 42^m$ II. Oc. R.; $26^d\ 3^h\ 24^m$ I. Sh. I.; $28^d\ 1^h\ 17^m$ I. Tr. E. Eclipses of the satellites take place low left of the disc, taking the direction of the belts as horizontal.

SATURN is an evening star in Gemini, but too near to the Sun for convenient observation; near Moon on evening of 3rd. 1° North of Venus at noon on 22nd.

URANUS is a morning star, but not very well placed. It has begun to retrograde. Semi-diameter 1″·8.

NEPTUNE is an evening star in Cancer. On 4th R.A. $8^h\ 11^m\cdot2$, N. Dec. 19°·8. On 28th R.A. $8^h\ 14^m\cdot3$, N. Dec. 19°·6. Semi-diameter 1″, magnitude 8.

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
May 30–Aug. ...	333°	+ 28°	Swift, streaks.
May–June ...	280	+ 32	Swift.
May–July ...	252	− 21	Slow, trains.
June–Aug. ...	310	+ 61	Swift; streaks.
June–Sept. ...	335	+ 57	Swift.
June–July ...	245	+ 64	Swift.
June–Aug. ...	303	+ 24	Swift.
June 25 ...	24	+ 43	Probable good display.

TABLE 27. Occultations of Stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance. Time.	Disappearance. Angle from N. to E.	Reappearance. Time.	Reappearance. Angle from N. to E.
1916.			h. m.	°	h. m.	°
June 4 ...	217 B Geminorum	6·3	7 37 *e*	187	7 56 *e*	222
,, 5 ...	WZC 608	7·2	8 33 *e*	94	—	—
,, 9 ...	WZC 771	7·1	10 51 *e*	44	—	—
,, 16 ...	4 G Sagittarii	6·2	0 48 *m*	359	0 53 *m*	353
,, 17 ...	127 G Sagittarii... ...	6·4	2 38 *m*	27	3 26 *m*	297
,, 17 ...	172 B Sagittarii... ...	5·8	3 30 *m*	41	4 25 *m*	283
,, 22 ...	λ Piscium	4·6	3 16 *m*	88	4 17 *m*	204
,, 24 ...	WZC 70	7·1	—	—	0 53 *m*	245
,, 26 ...	ε Arietis (double)	4·6	3 40 *m*	91	4 39 *m*	224
,, 27 ...	23 Tauri	4·3	1 50 *m*	25	2 24 *m*	305
,, 27 ...	27 Tauri	3·7	2 55 *m*	44	3 45 *m*	282
,, 27 ...	28 Tauri	5·2	3 6 *m*	21	3 40 *m*	306
,, 28 ...	BD + 24°·674	6·8	—	—	2 35 *m*	238

Attention is called to the grazing occultation of 4 G Sagittarii, and that of part of the Pleiades on June 27th.

GREENWICH TIMES OF MERIDIAN TRANSIT OF CERTAIN BRIGHT STARS.—These are given to facilitate the determination of time by observations with small transit instruments. The times for intermediate days may be obtained by simple interpolation. The Greenwich time of the stars crossing the meridians of other places may be obtained by expressing the longitude of these places in time, diminishing them by 9^s·83 per hour, and proportionately for fractions of an hour, then applying the result to the tabular time—positively for West longitudes, negatively for East ones. (See Table 28.)

Observers who know Greenwich Time can use the Table to obtain their South Point.

SUN before clock June 1, 144^s·02; June 6, 94^s·16; June 11, 36^s·92: after clock June 16, 25^s·10; June 21, 89^s·58; June 26, 153^s·98; July 1, 215^s·21. These are the equations of time for the moment of solar transit at Greenwich.

VARIABLE STARS.—Stars reaching their maxima in or near June, 1916, are included. The lists in recent months may also be consulted. (See Table 26.)

TABLE 28.

Day.	Arcturus.	α Coronae.	Vega.
	N. Dec. 19° 37′.	N. Dec. 27° 0′.	N. Dec. 38° 42′.
	h. m. s.	h. m. s.	h. m. s.
May 29	9 43 34·03 *e*	11 2 39·31 *e*	2 5 6·74**m*
June 8	9 4 14·91 *e*	10 23 20·21 *e*	1 25 47·81**m*
„ 18	8 24 55·72 *e*	9 44 1·06 *e*	0 46 28·84**m*
„ 28	7 45 36·51 *e*	9 4 41·89 *e*	0 7 9·82**m*

* Morning of May 30, June 9, 19, 29 respectively.

REVIEWS.

ASTRONOMY.

The Moon considered as a Planet, a World, and a Satellite.—By JAMES NASMYTH, C.E., and JAMES CARPENTER, F.R.A.S. 315 pages. 26 plates and 46 diagrams. 8¼-in. by 5¼-in.

(John Murray. Price 2/6 net.)

This cheap but beautiful reissue of Nasmyth's and Carpenter's classic is a remarkable production during the period of a world-war. The previous edition—the fourth—appeared in 1903; while the first three editions were dated 1874 and 1875. The most striking point in this well-known book is the artistic beauty of the plates of lunar detail. These are reproduced from photographs of relief models of the various regions, and are unsurpassed by any more recent publications dealing with selenography. Two plates are reproduced by the courtesy of the publisher (see Figures 102 and 103). As a reprint of a classic the book is beyond criticism; but it would have been rendered still more valuable had a note appeared reminding readers that it does not, in many respects, accord with present-day opinion on lunar evolution, and that much has been discovered in the past forty years that tends to discredit some of the conclusions based on the knowledge of a past generation. As the low price of this re-issue will no doubt lead to it being still more widely read, it is a pity that, for the benefit of embryo astronomers, no footnotes appear to correct misstatements. For instance, on page 296, Mars is grouped among the planets which have no satellites, a perfectly justifiable arrangement in 1874, when the book was written, but liable to mislead the beginner in 1916, as Mars' two moons—Deimos and Phobos—were discovered by Professor Hall in 1877. H. H. P.

CHEMISTRY.

The Theory of Valency.—By J. N. FRIEND. Second Edition. xiv+192 pages. 7-in. × 5-in.

(Longmans, Green & Co. Price 5/- net.)

There have been propounded so many theories of valency that a need has long been felt for a work which should deal with them concisely.

The present work (one of a series of textbooks on physical chemistry) supplies that need. In the opening chapters the author summarises the earlier theories, and discusses the question of valency and the periodic law. The valencies of the individual elements are then considered with reference to their groups. An exception is made in the case of carbon, which receives a chapter to itself.

Werner's theory is described in a certain amount of detail, and the summary given will be of value to those who are unacquainted with his work.

An excellent feature of the work is the portion dealing with electro-chemical theories of valency from the time of Davy onwards. In this connection it may be worth noting that the study of radio-activity has had a very marked influence on the conception of atomic and molecular structure, and therefore also upon valency.

This book will be found of great use to all who are interested in the subject, and the very numerous references to original papers lend an additional value to the work.

J. P. M.

The Molecular Volumes of Liquid Chemical Compounds.—By GERVAISE LE BAS. xii+274 pages, with diagrams. 9-in. by 6-in.

(Longmans, Green & Co. Price 7/6.)

The present work is essentially what is claimed for it—a monograph. The author has carefully assembled the most important results so far obtained in a study that has been somewhat neglected.

As the author observes in his preface, a more complete study of molecular volumes will probably throw further light on molecular structure. Therefore further research is to be encouraged, and the book provides an excellent summary of past work for anyone who enters upon investigation in this field.

J. P. M.

XUM

GEOLOGY.

On certain Channels attributed to Overflow Streams from Ice-dammed Lakes.—By T. G. BONNEY, Sc.D., LL.D., F.R.S. 44 pages. 8-in. × 5-in.

(Cambridge: Bowes & Bowes. Price 1/-.)

In this pamphlet Professor Bonney returns to the discussion of a subject that was dealt with in his Presidential Address to the British Association at Sheffield in 1910, namely, the origin of certain topographical features in Northern England whose genesis is still obscure. These valleys have been attributed by the extreme school of Yorkshire glacialists to the erosive power of streams formed by the melting of gigantic ice-sheets, supposed to have come in over the land from the North Sea and from the Irish Sea. In this connection two fundamental questions present themselves for discussion. Firstly, by what means did these masses of ice reach such great heights along the English coast; and secondly, supposing they did so, were they competent to produce the effects attributed to them? With regard to the first question, the mechanical difficulties involved are very great; and in the second it is hard to see how a stream running along the edge of the ice, which is naturally unstable and variable in position, was able to excavate such clean-cut trenches as are here described. It is significant that those geologists who are best acquainted with glaciers, by actual observation extending over many years, are the least inclined to admit their power of erosion on a large scale. While giving full weight to all the arguments both for and against the glacial hypothesis, Professor Bonney regards these remarkable channels as the relics of ancient drainage systems, of different ages in different parts of the country, but all agreeing in being pre-Glacial. In Cumberland they are possibly even pre-Triassic; while those of East Yorkshire and Norfolk appear to be of early Tertiary age.

R. H. RASTALL.

A Bibliography of Yorkshire Geology.—By T. SHEPPARD. 629 pages. 8½-in. × 5½-in.

(London, Hull, and York: A. Brown & Sons. Price, 15/-.)

The publication of this large volume has been undertaken by the Yorkshire Geological Society as a memorial of the late Mr. C. Fox-Strangways, who contributed so largely to our knowledge of the geology of the county. As the title implies, it is purely bibliographical. The book will be of immense service to workers in the Yorkshire district, and its value is greatly increased by a remarkably complete index.

R. H. RASTALL.

MINERALOGY.

Elements of Mineralogy.—By FRANK RUTLEY. Nineteenth Edition. Revised by H. H. READ. With Introduction by G. T. HOLLOWAY. xxii+394 pages. 7-in. × 5-in.

(Thomas Murby & Co. Price 3/6 net.)

The revision of this book has been undertaken with the idea of bringing an old well-tried textbook up to date and into line with the requirements of the economic mineralogist. This is the nineteenth edition of the book and some considerable changes have been made in it. Appendices have been embodied in the text, some chapters have been rewritten and economic information has been added wherever possible. The book falls into two portions, the first dealing with the properties of minerals, and the second with the descriptions of the species. The first part is shortly and clearly written, and contains some very useful tables of blowpipe and other simple tests for the identification of minerals, and also a chapter on optical properties, which is entirely new. In the second part a large number of species are described, with their chief occurrences; also their uses in the arts are given where these are important. No great stress is laid on crystal form in these descriptions, but this is no drawback, considering the economic tendencies of the book. There is a very complete index, and the book is well got up and clearly printed. It will be of great use to students both of mineralogy and mining.

W. H. WILCOCKSON.

Third Appendix to the Sixth Edition of Dana's System of Mineralogy.—By WILLIAM E. FORD. xiii+87 pages. 10-in. × 6¾-in.

(New York: John Wiley & Sons. London: Chapman & Hall. Price 6/6 net.)

This appendix brings the sixth edition of Dana's "System of Mineralogy" up to date, being a précis of all the new work on mineralogy between 1909 and 1915. One hundred and eighty new mineral names are quoted, of which some sixty are definitely new species. References are given to a great number of new occurrences and analyses, and new crystal forms are given where these are important. The application of x rays to the study of the molecular structure of crystals is noticed, and a list of papers on this subject is appended to the bibliography. The latter is fairly large, and is composed almost entirely of American and German works. The book is a useful and comprehensive summary of all recent work in the science.

W. H. WILCOCKSON.

PHYSIOLOGY.

Principles of General Physiology.—By W. M. BAYLISS, M.A., D.Sc., F.R.S. xx+850 pages. 259 illustrations. 10-in. × 7-in.

(Longmans, Green & Co., 1915. Price 21/- net.)

No one who has read the delightful book now before us will ever again think of physiology as a dull or narrow science. We have here brought together, in convenient and readable form, the latest work on the physiology of protoplasm, "the study of the endowments of living material." Consequently we find frequent references to plant, as well as animal, life, and much that is usually to be found in ordinary textbooks on physiology is absent. The author gives us the benefit of his wide reading, and constantly refers to the physical and chemical, as well as to the biological, sciences. At the close of each chapter is a short summary of the principal conclusions arrived at, and a list of the authors referred to in it. There is also at the end of the book an index of authors, with the references to their most important works, which is sure to be of the greatest value to the student. A human interest is given to the book by portraits of some of the greatest past and present masters of physiology, by facsimile pages from their books, and details of their lives. The book is well and clearly written, and represents a vast amount of reading, as well as much valuable research work. We cordially recommend it to the advanced student, and as a book of reference.

S. H.

NOTICES.

MR. C. LEES CURTIES.—We very much regret to announce that Mr. C. Lees Curties (a member of the firm of Charles Baker) died on April 24th after a short illness. Those who have had dealings with Mr. Curties in business, equally with his personal friends, will greatly miss his genial presence. We understand that Mr. Curties's partners (Mr. T. Hale Curties and Mr. C. Lees Curties, junior) will carry on the business as heretofore.

THE PHOTO-MICROGRAPHIC SOCIETY.—The annual general meeting of the Photo-micrographic Society will be held on Wednesday, May 10th, at 7 o'clock, at 62 Chandos Street, W.C., when there will be an exhibition of competition slides and members' work. Visitors are invited, and cards of admission may be obtained on application to the Honorary Secretary, Mr. J. G. Bradbury, 1 Hogarth Hill, Finchley Road, Hendon, N.W.

XUM